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ORIGINAL RESEARCH

Influence of the Cervical Enlargement in Determining the Diameter of the First File and Establishing the Working Length

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ABSTRACT

The objective of this study was to analyze the influence of different methods of cervical prepare in determining the first file of the apical preparation of root canal and working length. Thirty mesiobuccal fully formed roots of upper first permanent molars humans were used and the root canals were initially cleaned with K-file #10. Then, the teeth were randomly divided into three groups according to the type of enlargement: group I: ProTaper S1, SX; group II: K3 Orifice Opener 25.10 and 25.08; and group III: technique with hybrid K-type hand files and gates glidden drills # 3 and # 2. The specimens were taken to a stereo-microscope to evaluate the adaptation of the first file in the dentinal walls at length established. The data were submitted to Kruskal-Wallis and Wilcoxon tests. The reliability of the apex locator methods was performed by Spearman test. All groups showed statistically significant difference in the length of root canals after preparation of the cervical third ($p < 0.05$). The level of agreement between the measurement and visual electronics was higher (r = 98.07%) before the cervical enlargement, compared to that reported after cervical preparation (r = 96.42%) ($p < 0.0001$). Based on the methodology, was possible to conclude that cervical and middle thirds prepare were important to determine the first file diameter and it did lead to a decrease in the working length. The electronic apex was effective to determine the working length.

Keywords: Apical foramen, Endodontic files, Endodontics.

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INTRODUCTION

Among the procedures of endodontic treatment, the steps of the surgical access and preparation are essential to obtain the success. Despite its importance, there are still not well defined parameters as to some of its aspects.[1] Mechanical preparation is accomplished through chemical and mechanical ways. Regarding the mechanical part, the enlargement of the apical portion is critical issue widely discussed. The apical efficient cleaning is obtained by determining the correct working length and enlarged region.[2] The difficulties generated by the instrumentation of curved canals pose a real challenge. In this context, evidence-based endodontics has shown development of techniques based on parameter expansion toward crown-apex. The introduction of the file in the root canal is variable as coronary interference, poor flexibility of some files that provide tactile inadequate, and the presence of the pulp tissue that prevents the true correlation between the sense of adaptation and possible anatomic diameter.[3,4] It is necessary that the file be adjusted while maintaining contact with all the walls of the root canal and thereby promoting cleanliness.[5]

In the preparation step, the anatomic diameter is determined by the first file that has reached the working length, with some resistance, demonstrating to be adjusted to the walls.[1] The determination is defined by the ability to detect and tactile sensitivity of the apical constriction of the root canal. However, this technique was considered flawed method and empirical underestimated significantly, the actual diameter of this region.[2] For this, it is necessary to obtain direct and free access to the apical end conformation that allows the penetration of files without interference. The removal of any obstacles that may alter the course of files, prior to the onset of tooth length and apical modeling, it becomes imperative.[6-8] The extension of the cervical and medium third allows the file tip to work more lateral stress-free, providing instrumentation with respect to the original anatomy of the root canal steeper portion to the apical.[9] The determination of the actual diameter of the root canal anatomy allows to establish with greater security, the appropriate file to initiate and expand the apical preparation, providing removing contaminated dentin, favoring the treatment of periapical lesions.[2,7,10]

The correct achievement of tooth length in order to determine the longitudinal limit of instrumentation is very important to preserve the periapical tissues.[11,12] Several methods have been proposed for this purpose and, more recently, with the emergence of electronic foramen locators, a new feature was available in the arsenal. The achievement of cervical prepare allows greater penetration of the file into the root canal.[2,10,13]

Given the importance of modeling in apical endodontic treatment success, this study aimed to analyze the influence of different methods of cervical prepare in determining the first file of the apical preparation of root canal and working length, through the use of a electronic apex locator in mesiobuccal roots of maxillary first molars.

MATERIALS AND METHODS

This study was conducted after approval by the Ethics in Research, Faculty of Dentistry and Dental Research Center São Leopoldo Mandic.

Thirty mesiobuccal fully formed roots of upper first permanent molars humans were used that presented the degree of curvature between 25 and 40° according recommended by Schneider (1971).[14] Initially, the access to pulp chamber was prepared using a round diamond bur (KG Sorensen, São Paulo, Brazil) followed by irrigation of the pulp chamber with a solution of sodium hypochlorite 2.5%. Each root canal was explored with the relief of a K-file # 10 (Dentsply, Maillefer, Ballaigues, Switzerland), throughout its length to reach the apical foramen. The real working length was determined by inserting K-file # 10 to the exit apex, falling 1 mm, with reference to the buccal cusp. For further comparison the limit apex was also measured by means of electronic apex locator (Novapex, Forum Technologies, Israel).

The acquisition of the measurements by the electronic method was performed by inserting the tooth into a glass bottle containing vegetable sponge moistened with 2.5% sodium hypochlorite. The lip clip of the device was inserted labial side of the dental element in the vegetable sponge, simulating the conditions of the oral cavity. The K-file # 15 (Dentsply, Maillefer, Ballaigues, Switzerland) was attached to the door-files and inserted into the file reaches the mark 0 (zero) and subsequently performed the recoil of 1 mm by means of a millimeter rule, determining the working length. Then the files were taken to the working length to diameter setting, which was confirmed when the subsequent file is not able to penetrate into the root canal. The caliber of the file to set the root canal was noted, determining the anatomical diameter.

The teeth were randomly divided into three groups according to the type of enlargement done: group I: ProTaper S1, SX. (Dentsply, Maillefer, Ballaigues, Switzerland), group II: K3 Orifice Opener 25.10 and 25.08. (SybronEndo, Glendora, United States) and group III: Technique with hybrid K-type hand files (Dentsply, Maillefer, Ballaigues, Switzerland) and Gates Glidden drills # 3 and # 2 (Dentsply, Maillefer, Ballaigues, Switzerland). The nickel-titanium files were motor driven SMART-X (Dentsply, Maillefer, Ballaigues, Switzerland) at 300 rpm and torque of 3 N for up to 6 seconds, until it find resistance in the straight portion of the root canal, using gentle pressure, in the apical direction. Gates-glidden drills were engaged in low speed rotation. According to the hybrid technique was employed with K-type hand file bobbing up to file # 35 gauge. Every file change, the irrigation was performed with 2 mL of sodium hypochlorite at each change of file followed by Gates-Glidden drills # 3 and # 2 in the straight part of the root canal.

After the enlargement of the cervical and middle thirds was done the second length measurement of working length by visual method and electronic checking the real working length. K-files were introduced in the working length with the feeling fit, being confirmed when subsequent file failed to penetrate the working length. The file was adjusted to the diameter of the canal had noted his caliber. Later, with steel disk at low speed, were worn 1 mm apical segments of the mesiobuccal roots. Then the specimens were placed in a solution of 17% EDTA for 10 minutes, followed by sodium hypochlorite 1% for 10 minutes. The specimens were taken to a stereomicroscope (Zeiss Stemi, 2000c) with an increase of 30 times to evaluate the adaptation of the first file in the dentinal walls at length established. After this procedure, the roots were sectioned with the aid of a diamond disk (KG Soresen, São Paulo, Brazil) for removal of the cervical and middle portions, leaving only 5mm of apical segment. In this segment (5 mm), again, K-type files have been introduced to determine the one most set at the working length. The caliper of the file was then noted. The whole tooth/file was brought to a stereoscope to again assess the apical adaptation. The data were subjected to statistical analyze.

RESULTS

The results showed that the mean diameter of the apical portion of the mesiobuccal root of maxillary first molars before the cervical enlargement was 0.235 mm. After the cervical enlargement, regardless of the extension, the mean anatomical diameter increased to 0.316 mm. When the cervical portion was removed it was possible to impart a diameter of 0.383 mm apical region, as can be seen in Table 1.

According to the groups, group I, where the cervical enlargement was done with the system S1 and SX ProTaper, the mean diameter of the first file was 0.240 mm. After preparation of the cervical and middle thirds, the mean

Table 1: Measurement of the apical diameter of the root canal before cervical enlargement

Measure technique	*N*	*First*	*Second*	*Third*
ProTaper	10	0.240 ± 0.459	0.315 ± 0.709	0.390 ± 0.119
K3	10	0.240 ± 0.614	0.320 ± 0.823	0.420 ± 0.133
Manual technique	10	0.225 ± 0.634	0.315 ± 0.818	0.340 ± 0.124
Mean		0.235 ± 0.559	0.316 ± 0.758	0.383 ± 0.126

diameter of the file was increased to 0,315 mm, and when the cervical portion was removed it was possible to give a diameter of 0.390 mm for the apical portion of the mesiobuccal roots of maxillary first molars. In group II, when the system was used K3 Orifice Opener 25.10 and 25.08, for the preparation of the cervical portion and mean anatomical diameter at baseline was 0.240 mm. After cervical prepare increased to 0,320 mm, and when removed the entire cervical portion was recorded a mean of 0.42 mm. In group III, was used for cervical prepare Gates-Glidden drills and K-type files, the mean anatomical diameter was 0.225 mm. After cervical prepare, the mean increased to 0,315 mm, and when removed the entire cervical portion was found to have increased in diameter, becoming registered mean 0.340 mm.

According to Table 2, the variation in the diameter of the file before and after cervical prepare, when using the system ProTaper, diameter increased by 1 in 50% of cases. The increase 2 to 3 diameters, respectively, occurred in 20% and only 10% showed no variation in diameter. When using the K3 system, there was an increase of two diameters on the file after the cervical enlargement in 50% of cases. Since only 10% diameter increased by 1. When the cervical preparation was performed with Gates-Glidden drills and K-files, there was an increase of 2 diameters of the file after cervical prepare in 60%. In all samples it was possible to increase the diameter of the tool, with 30% increase in 1 diameter and 10% increased 3 diameters. It was observed that the group III promoted a greater increase in the diameter of the tool, a mean of 9 to 8 mm of group II and 7.5 mm of group I.

When compared to the first adjusting file in the apical region of the three groups was observed that no file is adapted presented in the apical portion, as shown in Table 3. After the enlargement of the cervical and middle thirds was no increase in diameter of the file, with positive reaction in the adaptation of the file in the apical portion of the root. The best adaptation of the file after cervical prepare was observed in group III, in 60% of cases. Followed by group II, which had 30% of suitable files in the apical region and

Table 2: Distribution of the teeth number according with degree of increase of the file diameter and system

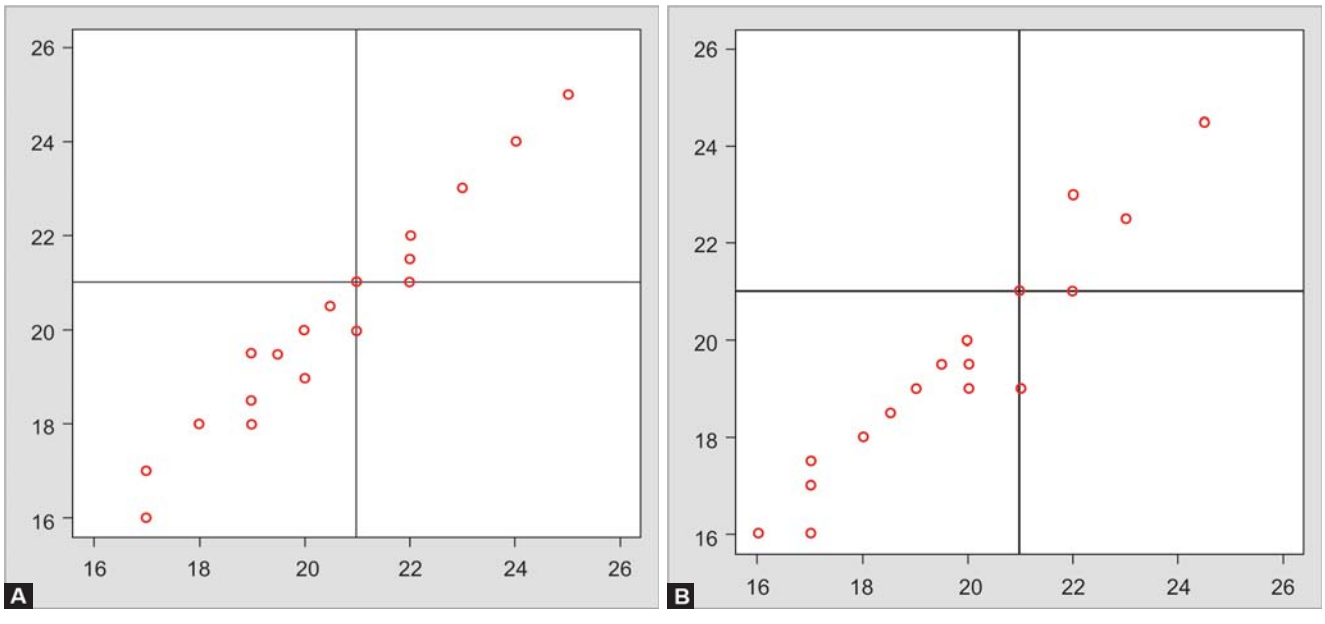
System degree of increase of the file diameter	*ProTaper*	*K3*	*Manual*
0	1 (10%)	1 (10%)	3 (30%)
1	5 (50%)	3 (30%)	6 (60%)
2	2 (20%)	5 (50%)	1 (10%)
3	2 (20%)	1 (10%)	3 (30%)

Table 3: Adaptation of the first file in apical portion before cervical enlargement

Type of file	*Frequency (%)*		
	First	*Second*	*Third*
ProTaper	0	20	40
K3	0	30	80
Manual	0	60	70

Table 4: Difference, in millimeters, between initial and final working length according with type of cervical enlargement

System difference	*ProTaper*	*K3*	*Manual and gates glidden*
–3.0	1	0	0
–2.0	2	0	0
–1.0	5	3	4
–0.5	0	0	2
0.0	2	2	4



Figs 1A and B: Accordance of the electronic method with the visual measure, both before (A) and after (B) cervical preparation

20% adaptation of group I. After removal of all cervical portion roots was greater caliber can insert files in the apical portion, thereby contributing to better adaptation of the file in the apical region. group II has a percentage of 30 to 80% of adaptation. group I began to adapt by 40%. In group III, the percentage rate adaptation in this stage was 70%.

Evaluating the change in working length, before and after the cervical enlargement, the results demonstrated by the Kruskal-Wallis test that in all groups there was a decrease in the length of root canals after preparation of the cervical third, a statistically significant difference ($p < 0.05$) variation in the length of the root canal, between analyzed group. Wilcoxon test showed that group I had the highest rates of variation of root canal length after cervical prepare, as shown in Table 4.

The effectiveness of the finder was determined by comparing the visual measurement to electronic measurement, both before and after cervical prepare, regardless of the extension used. Regarding the reliability of the apex locator, the level of agreement between the measurement and visual electronics was higher ($r = 98.07\%$) before the cervical enlargement, compared to that reported after cervical preparation ($r = 96.42\%$) (Spearman test $p < 0.0001$). According to the results, it was found that the electronic method was concordant with the visual measure, both before (Fig. 1A) and after (Fig. 1B) cervical prepare, with excellent accuracy.

DISCUSSION

Endodontic literature can be seen that the technique of enlargement of the cervical and middle thirds is a critical factor determining the success. Studies attest to the efficiency and safety of the files used for this phase of treatment with wide range of endodontic techniques that highlight the importance of this procedure prior to instrumentation of the apical region, in order to improve the quality of root canal preparation.[6-8,15-17] Associated with this, the correct determination of the length of work permits to establish with greater security, not only that the limit should be cleaning and shaping the canal, but also lets you choose the tool with which to start the preparation and how much will be needed enlarge it. Especially in cases of severe curvature teeth, there is more difficulty in apical preparation as a consequence of dentin at the entrance of the root canal.[8,17] These interferences represent an obstacle for the free access of the file in the apical portion, reflecting false sense of locking it.[13,18]

The visualization of the tip of the file allowed the establishment of the working length of visual form when the indentation of 1 mm from the apical foramen. Thus, a parameter was established for comparison with the use of electronic foramen locator. K-type files have been introduced for determining the setting of the first file root canal. If the subsequent file could not penetrate to the working length, the file was set. For that different files were used for this extension that respected the principle crown-dow. The use of three different types of cervical reamers was performed in order to compare the preparation of the cervical portion of the root canal with each file and the relation of the removal of interferences in the determination of cervical apical anatomic diameter and length measurement work. To measure the effectiveness of the proposed extension, everywhere cervical and middle root was removed, leaving only the apical 5 mm. To check the adjustment of the files in the apical third was removed 1mm from the apex, which represents a setback established for the working length, which facilitated a better view of this adaptation. The use of a stereoscope, an increase of 30 times, favored the better view.

In this study, the interference removal cervical allowed the insertion of larger diameter files in the set working length. These results are in agreement with those found by other authors.[6-8,15-17,19-21] The group using Gates-Glidden drills and stainless steel hand files had a higher increase in the diameter of the file when compared to the system ProTaper and K3. It is likely that the use of drills and hand tools promoted greater dilation of the cervical and middle thirds, an important factor for more precise adjustment of apical file.[22] It was observed in this group the best response adaptation apical file. Barroso et al (2005)[15] obtained better results in the adaptation of the file when the cervical preparation was performed with LA Axxess.

All the samples showed that before the cervical enlargement, the initial file was not adapted in the apical third, with space between the file and the canal wall. Results in line with the literature and confirm the assumption that the determination of the initial apical, before the cervical enlargement, in most cases, does not reflect the actual diameter of the root canal.[2,6,15,19] After the cervical enlargement, it was possible to insert files of larger diameter in the apical region, getting positive response regarding the adaptation of the file. The mean anatomical diameter, for the group that used the Gates-Glidden drills corresponded to a # 30 K-file. This file may represent the initial apical to the mesiobuccal roots of maxillary first molars. group II, which used the K3 rotary system, got an adjustment of 30 and 20% of group I. After complete removal of all cervical and middle portion of the root canal, it was possible to insert files of greater caliber. Even so, it was not possible to obtain 100% adaptation. The lack of adaptation to the variation of

the anatomy where root canals had had no tape format suitable files due to endodontic file does not match the anatomy of the root canal. These results are in agreement with those found in Paque et al study (2010).[18]

Currently, with the new scientific view, several authors stressed the presumption of actual determination of the initial apical file (IAF) to promote microsurgery proper apical root canal.[6,10,19,20,23] It is given a positive association of determining the anatomical diameter prior to enlargement of the cervical and middle thirds. With the elimination of interference cervical, more accurate measurements are achieved. Normally, the mesial canals of maxillary molars have their instrumentation started with file # 10 or # 15 for ease of penetration of the file and feel fit at the working length. However, Kuttler (1955)[25] determined the mean diameter of the apical cementum-dentine border root canal of about 0.30 mm screen in patients ranging from 25 years of age and 0.27 mm in patients over 55 years of age. Insofar 1 mm short of the radiographic apex, the mean minor diameter is around 0.22 mm and larger around 0.33 mm.[26] In the present study it was found that after the enlargement of the cervical and middle thirds, regardless of the technique, the diameter of 0.316 mm, which is consistent with the results found by Kuttler (1955)[24] and Green[25] (1958). Thus, starting canal preparation with a small diameter file (# 10 or 15) would make the cleaning and shaping of that root canal unsatisfactory due to inadequate adaptation of the file.

It was proven in this study that the completion of the preparation of the cervical and middle thirds lead to a decrease in the working length, regardless of the technique, due to the change (decrease) in the degree of root canal curvature and consequent lower angle from the file.[22,26] The largest decrease in working length was determined by means of the ProTaper (SX and S1). This is attributed to high shear and extension centralized file that reproduces. Nickel-titanium rotary files type Orifice Openers also had a greater reduction in the length of labor, compared with Gates-Glidden drills.[26] Different results were obtained by Davis et al (2002)[22] who associated hand files to Gates-Glidden drills, getting greater decrease in the length of labor. These drills perform the rectification of the root canal, while the nickel-titanium rotary files are characterized remain centered within the root canal during instrumentation, minimizing root canal straightening, causing minimal changes in root canal configuration, keeping the original form of the root canal.

The electronic foramen locators represent a viable alternative for obtaining assist the working length of the root canal. However, the degree of precision between the devices available has shown considerable variation. When compared the effectiveness of the apparatus was checked for agreement with the electronic method to measure visual both before and after preparation cervical line with results from the literature.[23] Other findings demonstrated the positive cervical enlargement to improve the pass of the file to the foramen and consequently the measuring electronics by means of devices.[27,28] Stabholtz et al[23] (1995) showed that when it was done the previous preparation of the cervical and middle thirds, 75% of the files were located 1 mm from the apex, while in the group in which the extension was not performed, only 35% of the files were located this measure. Evidences of the influence in determining the apical constriction, besides decreasing the accumulation of debris in the apical third, which complicates the determination of foramen and then the performance of the foramen locators. In this study, the device was effective both before and after the cervical enlargement. This can be attributed in proximity to the diameter of the file root canal, aiding in obtaining predictable results. It is believed that further studies should be conducted in order to establish an efficient in determining the choice of the first file for the beginning of canal preparation and ensure the maintenance of the working length throughout this phase of endodontic treatment.

CONCLUSION

Based on the methodology, was possible to conclude that cervical and middle thirds prepare were important to determine the first file diameter and it did lead to a decrease in the working length. The electronic apex was effective to determine the working length.

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